
III. *A Letter from Mr* Antony Van Leuwenhoek, *F. R. S. Concerning ſome Foſſils of* Swiſſerland, &c.

Delſt, *the* 13*th* Decemb. 1704.

LAſt *February* I imparted my Thoughts and Obſevations to the Learned and Famous Monſieur *Peter Valkenier*, Envoy from the *States General* to the *Swiſs Cantons*, about *Mountain-Criſtal*, and particularly that it was not produced from Ice, nor grew in the Mountains, where it has its Increaſe, as many are of opinion; but that it is coagulated of the Air, there where it is fixt in the Mountain, that Air and a little Moiſture is ſhut up in Cryſtals; the Parts of which being ſeparated, are again reſolved into Long Particles, of which a great many are Hexangular.

When the ſaid Gentleman return'd from *Swiſſerland*, I obſerved in his Houſe divers Shells of Fiſhes, and Snails, and other Rarities, which were Petrify'd, and a great many turn'd into Metal, with which he had fill'd a Cabinet; having made the Collection among the Mountains and Rocks of *Swiſſerland*. A few weeks ago Mr *Valkenier* did me the honour of a Viſit, and among other things, gave me four of the little Snail-ſhells that he had gather'd in the ſaid Mountains, where thro length of time they were chang'd into Metal, for they were extraordinary Heavy.

For my farther ſatisfaction, I took one of the Snail-ſhells, that I judged to be Metal, and beat it to pieces with a little Hammer; but finding that it broke very eaſily, I ſeparated the parts with the leſs trouble, and broke the fore-part of it with my Fingers, a ſmall part of which, repreſented by Fig. A B C D E, I placed before a Microſcope, of which B C D was what was joyn'd to the fore part of the Snail-ſhell, and wherein I obſerved ſix prominent Particles, and five others at A E; the which five were fitted or inſinuated into the ſix Particles; and how often ſoever I broke the ſaid Shell in pieces, I ſtill obſerved in the fore-part ſix, and in the hind-part five Particles, in the ſame order and diſpoſition; ſo that I fancy it muſt have been a Limb or Part of the incloſed Snail, and conſequently that it had been once a living Creature.

Having placed one of theſe little pieces of Snail-ſhell with the Break of the ſame before a Microſcope, I obſerved that the Matter within was compoſed of very ſmall ſhining Particles, which one would take to be broken pieces of Metal.

Foraſmuch as I have ſeen ſuch like ſeeming Particles of Metal, which was really nothing but Brimſtone, I took ſome of the little pieces of the Shell, and put 'em into a Glaſs, and then upon the Fire, and obſerv'd, that in proportion to the ſmalneſs of the Parts, a great deal of Water and Sulphur was drawn off of 'em, without diſcovering the leaſt ſign of Metal in the remaining Black Matter.

Moreover, I examin'd that little piece of Matter, which, as I ſaid before, I judged to have been the living Creature within the Shell; by its uncommon Weight it ſeem'd to be alſo turn'd into Metal, and the more when I had broken it to pieces, for then the manyfold exceeding ſmall ſhining Particles appear'd to be wholly Metallin.

The aboveſaid Matter was extraordinary hard, inſomuch that when I ſtruck it againſt a Steel, as they do with a Flint ſtone, it yielded Sparks of Fire; I beat off a piece of it, and placed the remainder before a Microſcope, which ſhow'd itſelf as Fig. 2. F G H I, the Break of which is repreſented by G H. On which ſide, the more one view'd it, the more ſhould one be perſwaded that the many ſmall ſhining Particles were certainly Metallin; but when I brought it to the Fire, and endeavour'd as much as I was able to keep the Smoak together, it appear'd plainly to me to be nothing but Sulphur, which was not only manifeſt by the ſmell of it, but that which was drawn off was of a yellow Colour, juſt as Sulphur appears to our naked Eye.

Now that Fig. 1. A B C D E is a part of a real Snail is clear to me, but how, and after what manner the Sulphur gets into the Horn, we can only gueſs. My opinion of the matter is this: The Snails and other things that are found upon the Mountains of *Swiſſerland*, and which are ſuppoſed to be changed into Metals, have lain, and do ſtill lye where a great quantity of Sulphur is ſhut up in the Bowels of the Earth; and that Sulphur, by a Subterraneous Heat or Warmth being render'd Fluid, mounts upwards in exceeding fine Particles like Fire, and ſo inſinuates itſelf not only into the inmoſt parts of the Snail-ſhell, where, according to all appearance, the Snail itſelf is almoſt conſumed, but alſo into the Pores of the Horn or Shell, and is there fixt and coagulated, ſo that the whole Snail is converted into a Sulphureous Subſtance.

This may ſeem ſtrange to ſome people, but thoſe that have dealt in Sulphur, and know into what an unſpeakable great number of ſmall parts it can be divided by Fire, they can eaſily conceive into what a number of Bodies, Sulphur, being put into a Fluid Motion, can inſinuate itſelf in ſome Ages; for, according to the opinion of the Learned Mr ......, as I have been inform'd, theſe Snails, and other Teſtaceous Animals, which are found in the High Mountains of *Swiſſerland*, have lain there ever ſince the Deluge; and ſo many of them by length of time are turned into Metal; or rather, according to my Hypotheſis, are moſtly Sulphur.

Now, in order to ſet before my own Eyes anew the exceeding ſmall Particles into which Sulphur is divided by Fire, I prepar'd a little Glaſs Globe repreſented by Fig. 3. A B C D, and placed in it at B, a ſmall particle of Sulphur about the bigneſs of a ſingle Corn of Sand; and when the Glaſs and the Air within it was ſo Temperate as to agree with the Air we commonly breathe in, I ſeal'd that part of the Glaſs which was open at E Hermetically, and then blow'd the Flame of a Candle upon the other part of the Glaſs where the Sulphur lay, till it evaporated into Smoak, which Smoak for a ſmall ſpace of time was carried about the Glaſs in a Circular Motion; and after that the Sulphureous Smoak ſubſided, and ſettled it ſelf on the Glaſs, I examin'd it with a Microſcope, and obſerved ſo many exceeding fine Particles on the ſides of the Glaſs, that no man ſcarce could believe that ſuch a ſmall grain of Sulphur could poſſibly be divided into ſo many parts; inſomuch that the ſmalleſt Globules of this divided Sulphur could hardly be ſeen with one of my beſt Glaſſes, and the largeſt Globules lay round about the Sulphureous Matter that was not quite diſſolved.

I let the Glaſs Sphere lye ſtill about half an hour, and then view'd it anew, (and obſerved with wonder that ſome of the ſmall Globules of Sulphur, that lay a little remote from the reſt, form'd themſelves into a right line, and that 4 or 5 were placed lengthwiſe, and ſome Globules were ſo extended in length, that they toucht one another; but ſome hours after they were all united, and ſo compoſed one little body juſt like Salt-petre, when being joyn'd to Water, it begins to coagulate.

This Inclination or Coagulation was wonderful to me; and the more, becauſe ſome of theſe Coagulations were twice, others three times as long as ſome others that lay thereabout; and juſt by theſe coagulated long Particles lay other Sulphureous Particles, but none very ſmall.

'Tis

'Tis true, we ſee daily in Fluid Subſtances, thro' a Secret Inclination, that Homogeneous Particles coagulate together, but how the Particles of Sulphur, that are as it were glew'd down to the Glaſs, ſhould aſſemble and unite in one body, is very wonderful to behold.

I had one Snail-ſhell, repreſented here by Fig. 4. K L M N O, which was extraordinary heavy in proportion to its bigneſs, and which ſeem'd to me not to be quite whole, but that ſome part of it was broken off, as at L M.

I endeavour'd to break this Shell to pieces with my Fingers, but was not able, wherefore I laid it upon ſome Lead, and ſo broke it to pieces.

I wanted no Microſcope to view theſe broken pieces, which ſeem'd to be full, excepting the ſlendereſt part of the Tail, with a pale yellowiſh ſubſtance, that was viſible enough to the naked Eye.

To ſatisfie my ſelf about the ſaid appearing Metallin Particles, I put about a fourth part of the laſt mention'd Snail-ſhell into a Glaſs, and brought it to ſuch a ſtrong Fire, that the Glaſs was upon the melting; in doing which, I ſeparated a great deal of Sulphur (in proportion) from it, and when I took the remaining Matter out of the Glaſs, I ſaw that all the Sulphur was not extracted from it, for I diſcovered ſeveral Sulphureous Particles lying in the remaining Matter, which one would take for a black burnt Earth; and they were divided from each other in longiſh Particles, each of 'em having diſtinct Figures, agreeable to the places which they were to fill.

I ſeal'd up hermetically the Glaſs wherein the extracted Sulphur was coagulated, to the end that no Moiſtneſs or Vapours ſhould get into it, nor none come out, and then I view'd thoſe Sulphureous Particles that had lain fartheſt from the Fire, and ſaw that the Glaſs (tho' nothing thereof was perceptible to the naked Eye) was cover'd with Globules, juſt as if one had ſpread a Table all over with Sand; and when I view'd the ſame a little while after, I ſaw the ſmall Particles were coagulated together in irregular Figures; and as I did imagine before, that the ſmall Sulphureous Particles were faſtned to the Glaſs, now I ſaw an Oleagenous and Watry Subſtance, which one might call the Spirit of Sulphur, drawn off together with the Sulphur, and that ſeveral places in the Glaſs were without the Globules, and nothing but ſome of this Oleagenous Matter to be ſeen.

I had alſo a third Snail-ſhell, whoſe outmoſt part, or Shell, was as ſmooth as if it had been Poliſht; and when I lookt upon it thro a Microſcope, I obſerved that the Horn or Shell had been adorn'd with wonderful Figures; from which ſight I concluded that the Glanſe, or ſmoothneſs of the Shell was occaſion'd by the long and frequent Attrition of the ſame againſt other hard Bodies, before it could get any Reſt in the High Mountains; as we ſee in hard Stones that are found on the Sea ſhore, which by the frequent Motion of the Waves or Sand about 'em, become very ſmooth and poliſht; and 'twas by ſuch Motion that the fine Figures in the Shells are quite worn out.

This Shell deſcribed by Fig. 5. PQR I could break very eaſily with my Fingers, and with my naked Eye diſcover that it was for the moſt part compoſed of the abovemention'd ſhining Matter. as it was alſo for the moſt part full of Sulphur.

I had another Snail-ſhell, repreſented by Fig. 6. TVW, which was alſo very ſmooth, and when I broke that Shell in pieces, that which ſeem'd to be ſo ſmooth to the naked Eye, appear'd now with as many ſcratches as if it had been rubb'd with ſharp Sand; and this was adorn'd with Figures too that were not diſcernable with the naked Eye; a ſmall part of which is here deſcribed by Fig. 7.

AB.

A B C D E F G H, which was raiſed a little above the other part of the Shell, and ſome part lower, as B C D.

The abovemention'd Monſieur *Valkenier* put into my hands a little Body, whoſe form or ſhape is repreſented in Fig. 8. X Y Z, which is alſo found on the high Mountains of *Swiſſerland*, which ſeeming to the Eye to conſiſt of three Joynts, I endeavour'd to ſeparate 'em from one another, in order to diſcover, if poſſible, the internal figure of it; and tho I attempted to cleave it thro in the joynted parts with a ſharp Steel, I could not compaſs it, but broke it into irregular pieces, all which were ſo ſmooth and ſhining within, that the like never occurr'd in any common Stone; and it was moreover more than ordinary hard; the beſt judgment I could make of it was, that it was compos'd of flat parts.

I laid the biggeſt piece of it upon Wood coal, and brought it leiſurely into a ſtrong glowing heat; in doing which, at firſt ſome Splinters of it burſt away, and I could not perceive that there was any Sulphur in it; whereupon I dropt it into a ſmall Copper Veſſel in which there was not above a Thimbleful of Water, to ſee whether that would ſeparate the Parts, in order to diſcover the Homogeneous Parts the better; but inſtead of doing ſo, it divided into a vaſt number of unſpeakably ſmall white Particles, to which one may give the name of a Chalky ſubſtance.

As ſoon as this Chalky Matter was ſeparated, I obſerved a Film or Scum upon the Water, which I took to be the Coagulated Salts thereof.

I took a little of the ſaid Water from under the Scum, and poured it upon a clean Glaſs, and viewing it preſently after, I diſcover'd, to my great Amazement, ſo many Clear and Tranſparent Salt-particles (many of which were ſo fine and ſlender, that they ſeem'd to have but one Circle or Circumference) and of ſo various and different figures, that I believe no Painter, tho' his fancy were never ſo fruitful, could invent ſuch a number of Figures, or trace them upon Paper , as I there ſaw; and they were ſo very ſmall, that ſeveral Thouſands of 'em together could not equal the magnitude of a ſingle grain of Sand; and foraſmuch as a very great many of 'em were long, I fancy'd to my ſelf that that Figure might be peculiar to them, and that all the reſt had only aſſumed a borrowed form, which might be determined by the different manner of their uniting or coagulating in ſeveral places.

I let the Water ſtand upon the ſo called Chalky Subſtance a few days till it was all evaporated, and then I diſcovered a great number of very ſmall ſhining Particles lying at the bottom of the Copper-Veſſel, into which I had put the ſaid matter; all which I took out as clear as I could, and placed them on three ſeveral clean Glaſſes, aud then viewing 'em with a Microſcope, my wonder was much greater , for I did not only obſerve ſo very different Figures, that no two of 'em were like each other, but they were all of them as clear and bright as Cryſtal, yea, ſome of them had as fine and regular points as a wrought Diamond, tho' above a thouſand times ſmaller than a courſe Sand.

Among others, there appeared to me ſuch a Triple-jointed Body as is deſcribed by Fig. 8. X Y Z, which alſo endeavoured to ſeparate by its Joynts, but I could not ſucceed in this neither.

I laid this too upon a Wood Coal to make it glowing hot, as I had done the other, but a good part of it burſt away when it was but juſt warm, and as it began to be hotter, it made ſuch a buſtle, that if I had proceeded farther, I ſhould have kept none of it; whereupon I took a Glaſs Tube above a hands breadth long, and hermetically ſealed at one end, into which I put what remained of the above-mentioned Figure, and then heating that end of the Tube, the ſaid Matter burſt with great violence into ſuch ſmall Particles, that many of them ſeemed as fine as Meal or Flower, and if I had not ſtopt the open end of the Tube with my finger, moſt of this diſſolved Matter would have forced its way out from thence.

Afterwards I put the ſaid Tube into a glowing Heat, and then obſerved that a great deal of thin Watry Vapours were extracted from the reſt of the aforementioned ſubſtance.

I viewed the ſmall Particles that were in the inſide of the Glaſs, and I ſaw a great many very thin Scales, ſome of 'em having right Angles, and all of 'em ſeem'd to be compos'd of ſuch ſmall Particles, as fine Sand ſeems to be, to the naked Eye.

I took the aforementioned Matter out of the Glaſs Tube, and placed it upon a Wood-Coal, in order to put it into a greater Heat, but as ſoon as I had put it on the Fire, the ſmall Particles flew away ſo faſt, that I was forced to put it into the Tube again; and after having made it red hot, I poured it out of the Tube into the Water, but the Heat was not ſo great as to make it turn into a Chalky Subſtance, excepting a little piece no bigger than a Pins head, which I heated again without burſting or breaking, and dropping it into the Water it diſſolved into a Chalky Subſtance.

I had ſeveral ſuch like Particles but much ſmaller, and conſiſting of five Joynts or Ribs, which were alſo found upon the Mountains of *Switzerland.* This Particle, which is deſcribed by Fig. 9. I K, I ſlit thro the Joynts, but I could not do it ſo nicely, but that a ſmall piece of another Joynt ſtuck to the biggeſt; ſo that I could not ſo perfectly diſcover the Roſe-like figure, as it is repreſented by I.

I laid theſe ſlit Particles alſo upon Wood-Coal, intending to heat them leiſurely, but they made ſuch a buſtle upon the Fire, that in caſe I had proceeded, there had been none left upon the Coals; wherefore I put them likewiſe into a Glaſs Tube, as I had done before, but without any other ſucceſs, tho I held the Tube and the abovemention'd Matter in it, firſt in the flame of a Candle, that it might be leiſurely heated, and by this means it was ſo diſſolv'd, that it ſeem'd nothing but a Powder, and in this Operation there was alſo ſome moiſture exhaled.

From this wonderful Burſting, and that in ſuch ſmall pieces, I could conclude nothing elſe, but that a great many Watery Particles were ſhut up in this ſame Matter, and that theſe Particles were ſo ſtrongly united, and were moreover of ſo tenacious a ſubſtance, that it did not admit of the leaſt Evaporation of Moiſture; and theſe Watery Particles being rarify'd by Heat, demanded more ſpace, and ſo occaſion'd the Burſting of the abovesaid Matter.

I ſet the ſaid Tube with the Powder in it over ſo violent a Heat that it was ready to melt, and immediately thereupon pour'd the Powder into Water, but it did not turn to a Chalky ſubſtance; and afterwards decanting the Water into a Clean Glaſs-Tube, I obſerv'd it to be impregnated with Salt particles,

In doing this I ſaw a great number of exceeding thin Particles like Fig. 9. I K, upon the ſides of the Glaſs, and thoſe that were the thinneſt appear'd now juſt as the ſmall Holes on the outſide of a Thimble do to the naked Eye.

I placed ſeveral of the ſmall Splinters that burſt in the Fire before a Microſcope, and order'd my Painter to draw that of which he had the cleareſt view, as you may ſee by Fig. 10. N O.

This Splinter was ſo narrow, that it had but three Rows of little Holes, which were all three no broader than the Hair of one's Head; and in ſome other Splinters the Holes were yet ſmaller.

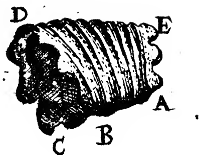
From theſe Diſcoveries, I conſider'd with my ſelf, whether there had not been ſome Matter ſhut up in each of theſe Holes, which being rarify'd by the Heat, demanded a greater ſpace to contain them; but being all faſt ſhut up, and having no paſſage through the Pores, was the cauſe of thoſe Bodies deſcrib'd by Fig. 9. I K, to burſt into ſo many thouſand pieces.

Now if we reflect on the wonderful Compoſition of the laſt nam'd Figure, and the infinite number of Salt Particles ſhut up within it, and the various figures of the Salts that were extracted from Fig. 8. we muſt lay our Fingers on our Mouths and cry out, O the Depth of theſe Secrets.

The abovemention'd Gentleman gave me, amongſt other things, two little Dice, of the bigneſs that is deſcrib'd by Fig. 11, L M, adding, that ſome people ſaid they were Stone, others Bone; and that theſe Dice were found in *Swiſſerland* deep under Ground, and in great numbers in a place, where formerly there had been a *Roman* Camp; and that the opinion of the *Swiſſers* was, that the *Roman* Souldiers had made uſe of 'em in play, whilſt they were encampt there.

I view'd a part of one of theſe Dice, and ſtruck ſeveral blows with a Hammer upon it, which indeed made Holes in it, but without breaking it; whereas if it had been Stone, it could not have withſtood ſo many blows; at laſt, having cut off ſome ſmall bits, and made 'em glowing hot in the Fire, I obſerv'd that it was black as Bone is, when it has not lain long in the Fire, and white when it lay longer. In my laſt viewing of it, I was ſtill the more confirm'd that it was Bone, for I could then diſcover the Pores of a Bone in it; yet in my opinion, it could not be made of the Bone of an Ox, becauſe the Parts were ſmaller.

fig : 1 ·



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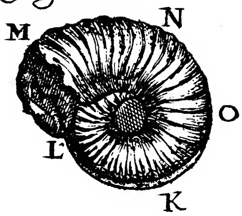

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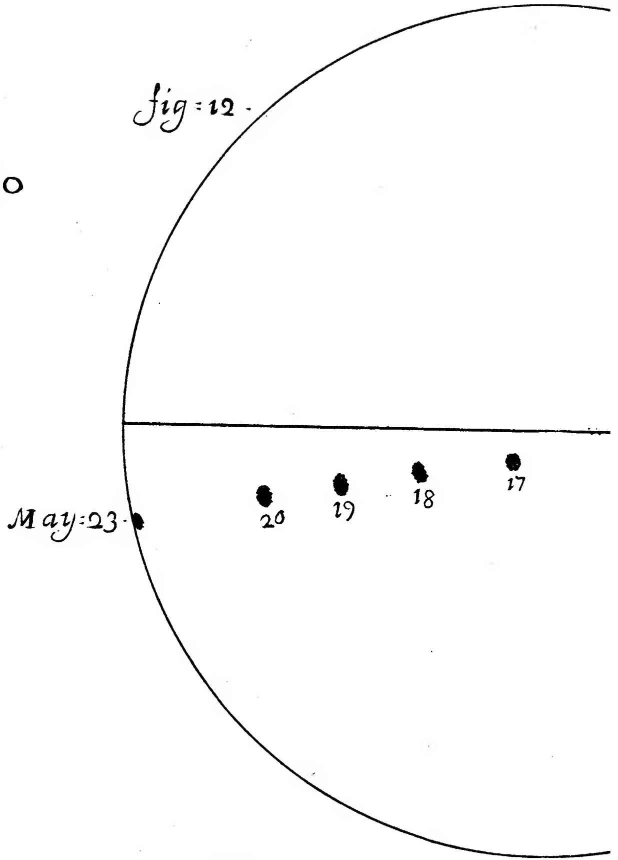

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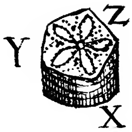

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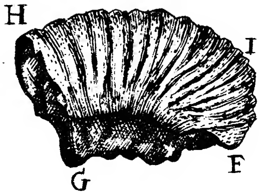

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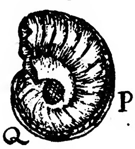

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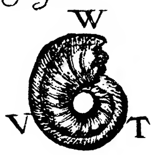

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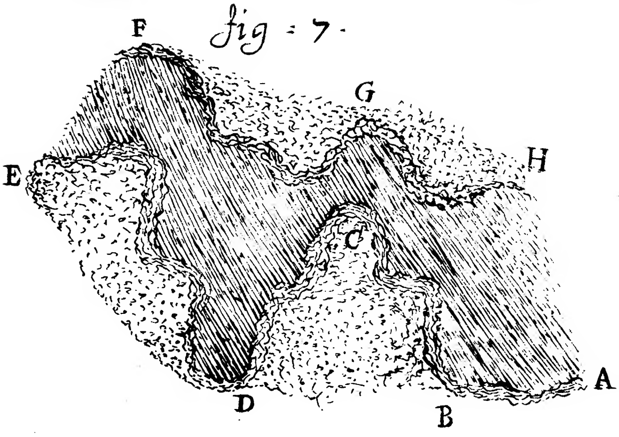

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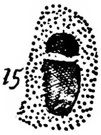

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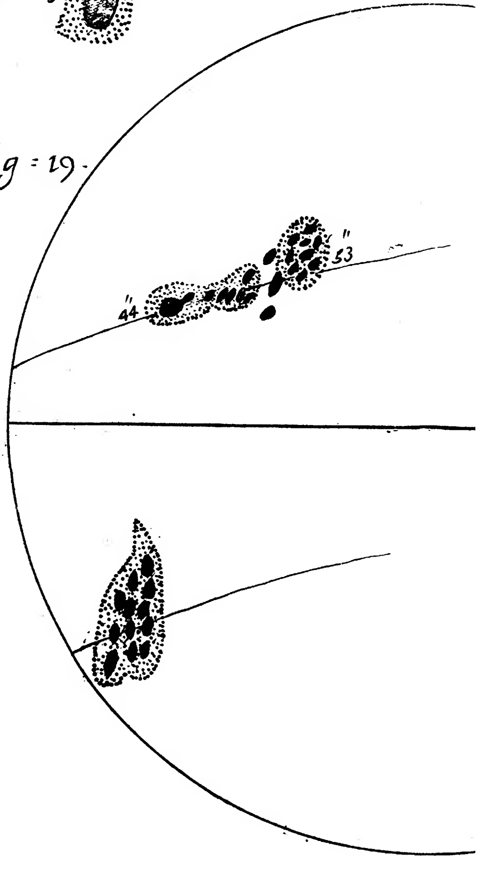

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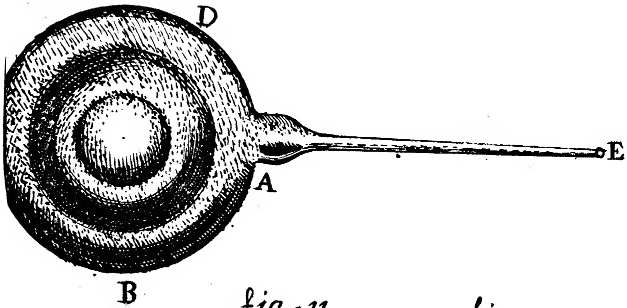
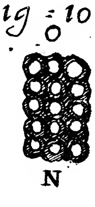


fig : 11 ·

fig : 10 ·



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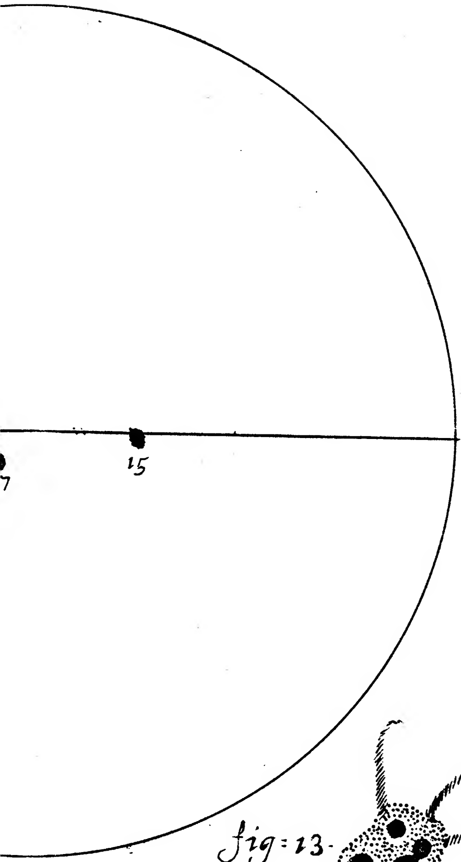

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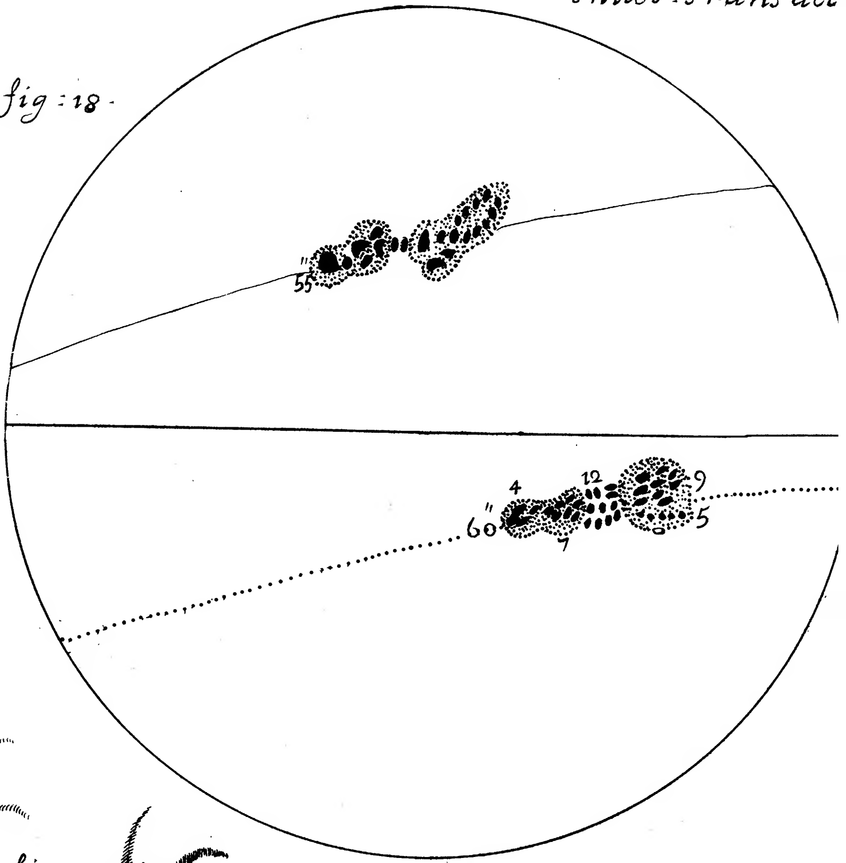
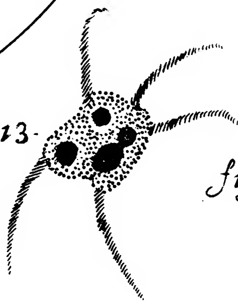


fig: 13.



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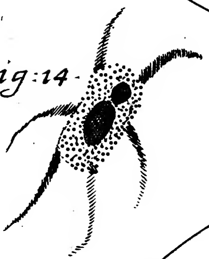

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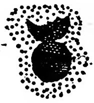

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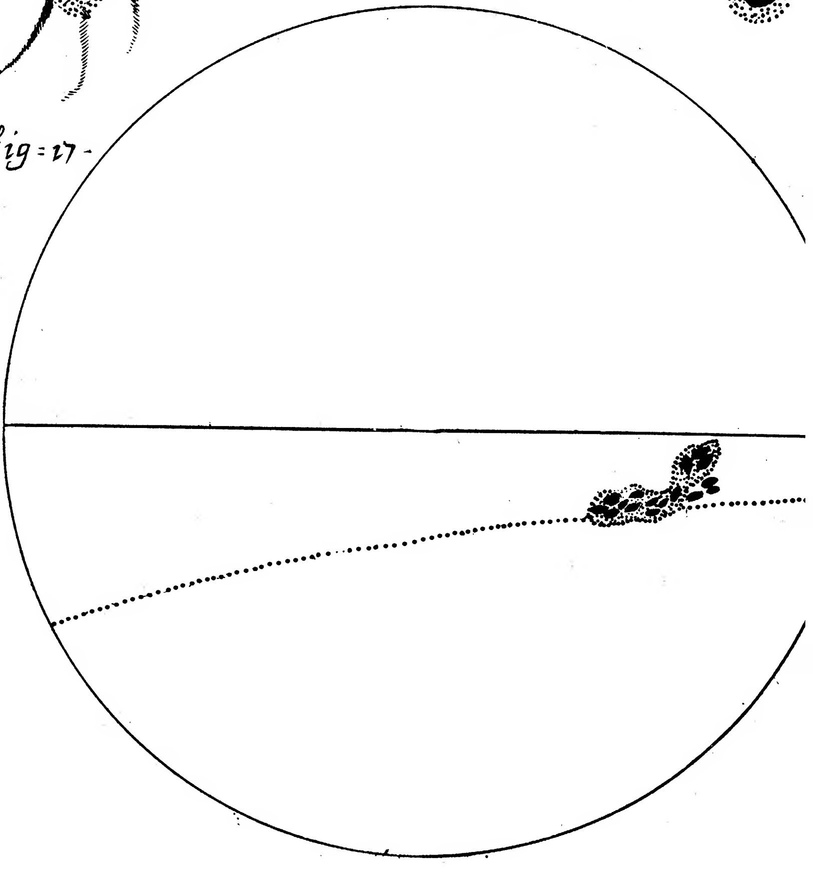

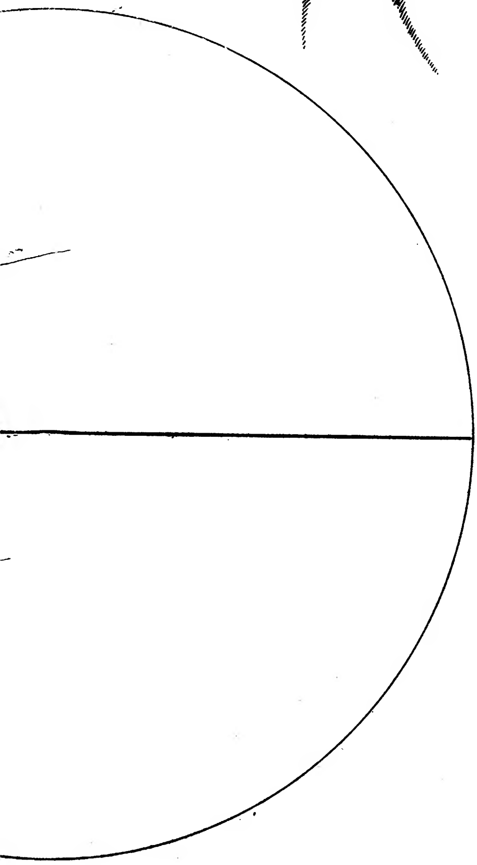

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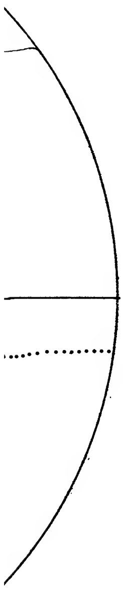

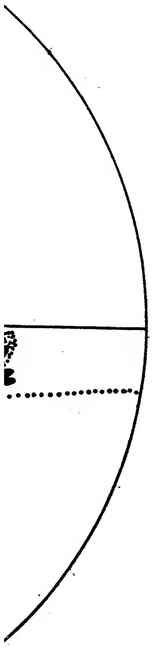

Fig 1

Fig 4

Fig 8

Fig 2

Fig 5

Fig 6

Fig 7

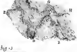

Fig 3

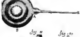

Fig 11

Fig 10

Fig 9

Fig 12

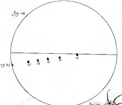

Fig 18

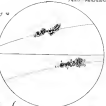

Fig 15

Fig 13

Fig 14

Fig 16

Fig 19

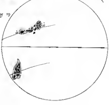

Fig 17